480 / 480E / 480E PRO CPM
Service and Technical Manual

QAL Medical™
OrthoAgility™
www.QALMedical.com

CUSTOMER CONTACT:
QAL Medical, LLC
(A division of Quality Assembly and Logistics, LLC)
3000 Woleske Road
Marinette, Wisconsin 54143 USA
1-888-430-1625; 1-715-735-4727
E-mail: info@QALMedical.com

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1.0 General Overview

1.1 Introduction

The purpose of this manual is to provide instructions for the basic maintenance, repair and service for the 480, 480E and 480E PRO CPM systems.

1.2 Safety Symbols

Danger!

Warning messages regarding possible risks of accident or injury.

Attention!

Warning messages regarding possible technical damages.

Note!

Information regarding operation of the device.

Note!

Information for service staff.

Attention!

Please read the Instruction for Use first.

1.2.1 General Safety Considerations

When using your CPM, to reduce the risk of fire, electric shock and injury to persons, basic safety precautions should always be observed, including the following:

Danger!

Keep hair, loose clothing, fingers, etc., away from moving components of the device.

Danger!

Do not expose the device to water, including ice bags. Do not expose to extreme temperatures.

Danger!

Turn the power off before unplugging.

Note!

Read and understand all instructions.

Note!

Follow all warnings and instructions marked on the product.

Danger!

Never install the power supply in wet locations.

Danger!

Never touch uninsulated wires or terminals unless the power supply has been unplugged from the wall.

Danger!

Unplug the power supply from the wall outlet before cleaning the unit. Do not use liquid cleaners or aerosol cleaners. Use a damp cloth for cleaning.

Danger!

Do not use this product near water.

Danger!

Do not place this product on an unstable cart, stand, or table. The product may fall causing serious injury to the patient or damage to the CPM.

Danger!

If you are not sure of the type of power supply, consult your QAL Medical representative or local power company.

Danger!

Do not overload wall outlets or use extension cords as this may result in the risk of fire or electric shock.

Danger!

Never insert objects into the drive unit casing as they may touch dangerous voltage points or short out parts that could result in a risk of fire or electric shock.

Danger!

To reduce the risk of electric shock, do not disassemble this product. Take it to a qualified serviceperson when service or repair work is required. Opening or removing covers may expose you to dangerous voltages or other risks. Incorrect re-assembly can cause electric shock when the unit is subsequently plugged in.

Danger!

If at any time during therapy the patient experiences extreme pain or discomfort, stop therapy and consult their physician.

Danger!

Unplug the product from the wall outlet and refer servicing to qualified personnel under the following conditions:

a. If the power supply cord is damaged or frayed.
b. If liquid had been spilled into the product.
c. If the product has been exposed to water.
d. If the product has been dropped or the unit casing has been damaged.
e. If the product exhibits a distinct change in performance.
f. If the product does not operate normally according to the operating instructions.

Danger!

Patient Safety: Patients must be advised to keep clear of moving parts. The unit is designed to force-reverse if an obstruction is under the cradle; however, a patient could experience pain or be injured by the downward pressure of the cradle if a body part is positioned under the cradle.

Danger!

Equipment not suitable for use in the presence of flammable anesthetic mixture with air or Nitrous Oxide.

Danger!

Unplug the product from wall outlet before servicing.

Attention!

Use only QAL Medical parts for repair and/or replacement.

Attention!

Never use parts from other manufacturers even though they may seem to fit.

Attention!

This product should be operated only from the type of power source indicated on the marking label.

Attention!

Do not allow anything to rest on the power cord. Do not locate this product where the cord will become damaged.

Attention!

Adjust only those controls that are covered by the operating instructions.

1.3 Specification

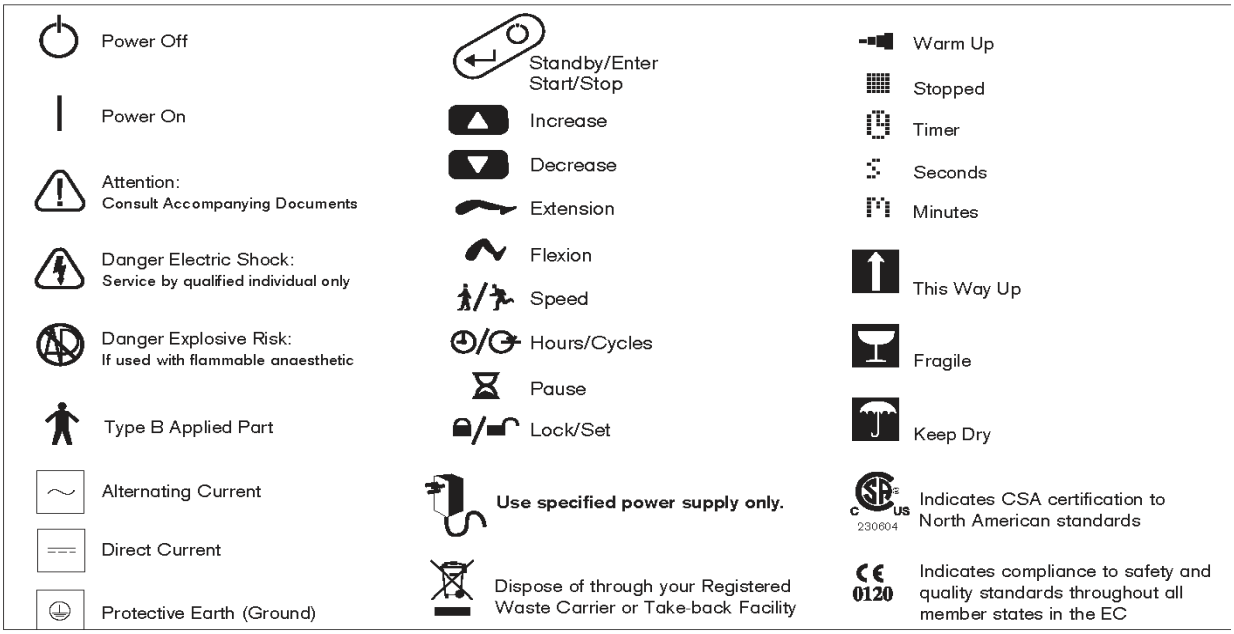
Weight Approximately 24 lbs. (11 kg)

	480 Standard	480 Pediatric	480E/480E PRO Standard	480E/480E PRO Pediatric
Limb Length	30.5 - 42 in (77 - 107 cm)	19.5 - 34.5 in (50 - 88 cm)	28.5 - 41 in (73 - 104 cm)	21.5 - 35.5 in (53 - 90 cm)
Calf Length	16.5 - 24 in (43 - 61 cm)	9.5 - 18.5 in (24 - 47 cm)	16.5 - 24 in (43 - 61 cm)	9.5 - 18.5 in (24 - 47 cm)
Thigh Length	14 - 18 in (36 - 46 cm)	10 - 16 in (25 - 41 cm)	12 - 17 in (30 - 43 cm)	12 - 17 in (30 43 cm)
Range of Motion	-5º extension to 110º flexion	-5º extension to 110º flexion	-5º extension to 120º flexion	

Speed:	16 - 160 degrees per minute
Pause:	0 - 30 seconds at maximum programmed extension and/or flexion
Mode of Operation Continuous	
480 Only Power Supply:	Input: 120 VAC 0.12A 60Hz or 230 VAC 0.6A 50 Hz Output: 14 VDC 730mA
Power Supply:	Input: 100 - 240VDC 1.6A 50 – 60 Hz Output: 15 VDC 2.0A
NMES:	480/480E Only – Compatible with various NMES devices
Shock Classification:	Type B
Classification:	Class 1 Medical Device (USA); Class 11a (93/42/EEC)
Environmental:	-10° to 35°C (14° to 95°F) temperature, 90% max. humidity
Conditions:	ATM pressure 750 hPa to 1040 hPa The device must remain in the operational environment a minimum of one hour prior to use.
Type of Shock Protection:	Class II
Degree of Shock Protection:	Type B applied part

1.4 Symbols

Fig 1



1.5 Suggested Maintenance Schedule

Between Patients

1. Check entire unit for any visible evidence of damage, such as bent sliders, cracked or broken covers, frayed or damaged wires, etc. If any signs of damage are found, the unit must be repaired before use.
2. Ensure that all knobs and/or levers are usable and in place.
3. Ensure that all moving components move freely as required.
4. Check all displays and electronic controls for proper operation.
5. Check all mechanical pivot and linkage points for smooth operation and secure mechanical connection. Make sure all screws, nuts, bolts, rivets, pivot pins, and other fasteners are secure.
6. Gently wipe clean all exposed surfaces with a soft cloth dampened with a mild soap solution or alcohol. Avoid abrasive cleansers. To disinfect, wipe all exposed surfaces with a 1% to 10% solution of bleach and water, or other suitable disinfectants.
7. Ensure that all labels are present.
8. Replace patient softgoods.
9. Verify that the device operates to its set limits over several complete cycles.
10. For devices offering absolute Range of Motion (ROM) settings, verify device calibration by observing the ROM of the device while taking a visual reading using a goniometer at the machine's pivot points. Compare the ROM settings of the device with the goniometer readings. ROM readings should be within +/- 5 degrees of the set parameters. If the readings do not fall within the set parameters, the unit needs to be checked and recalibrated by a properly trained Service Technician.

Every Six Months

1. Repeat steps 1 through 10 of "BETWEEN PATIENTS" procedures.
2. Verify ground continuity where applicable from the device frame to ground pin of the power supply, if so equipped, using a Safety Analyzer or appropriate device.

Every Eighteen Months

A full inspection of the device by a properly trained Service Technician is recommended every 18 months. The following points should be covered:

1. Steps 1 and 2 of "EVERY SIX MONTHS" above.
2. Fully inspect all internal and external mechanical and drive components, and repair or replace as necessary.
3. Fully inspect all internal and external electrical components (including wires, connectors and solder joints), and repair or replace as necessary.
4. Perform a complete recalibration and subsequent check of electronic and mechanical safety systems including Reverse-On-Load and Range of Motion.
5. Complete a final check of the device in accordance with QAL Medical Final Inspection criteria (these are available in the appropriate Technical Service Manual or on request from QAL Medical).

2.0 COVERS (480/480E/480E PRO)

2.1 Bottom Cover

Removal:

Note: Avoid cutting the heads off the plastic fasteners as these can be reused to reattach the covers.

1. Remove the Handle by removing the two Phillips screws located at each end of the Handle attachment.
2. Remove all 11 plastic fasteners from around the cover and separate the bottom cover from the unit.

Installation:

1. With the unit upside down, carefully place the bottom cover on the exposed frame.
2. Align the bottom cover's holes with the holes in the top cover.
3. Insert the female halves of the plastic fastener into the holes from which they came and insert one male half into each of the female halves.
4. With a small hammer gently seat the male halves of the fasteners.
5. Reinstall the handle. Use one drop of Loctite #425 on each attachment screw.

2.2 Top Cover

Removal:

1. Remove bottom cover (refer to section 2.1).
2. Remove cradle (refer to section 3).
3. With the bottom cover and cradle removed, the top cover comes free.

Installation:

1. Place the top cover on top of the exposed base frame.
2. Install cradle (refer to section 3).
3. Install bottom cover (refer to section 2.1).

3.0 CRADLE (480/480E/480E PRO)

Removal:

1. Remove the bottom cover (refer to section 2.1).
2. Using a pair of diagonal cutters, remove the ty-rap that holds the kneepot cable secure to the base.
3. Remove the kneepot cable strain relief from the top cover by removing the underside nut.
4. Pull the kneepot cable gently through the hole in the top cover.

5a. (480)

Remove both 3/16" cradle pivot cap screws from the U-bracket assembly to detach the cradle from the ballscrew. (If you run into difficulty removing the cap screw, apply a slight tilt to the Allen wrench and pull the entire cap screw, threaded insert, and pivot sleeve straight out.

5b. (480E)

Remove the six cap screws that fasten the U-bracket and angle brackets to the sliders.

6. Lift the cradle through the top cover.

Installation:

1. Gently spread apart the rubber track seals and slide cradle struts (480) or angle brackets (480E) between the track seals through the top cover.

2a. (480)

Replace the slider blocks with new ones. Position the cradle strut between the slider blocks and the U-bracket, and reinsert the spacer into the hole in the cradle strut. Place both pivot sleeves into their proper locations. Apply one drop of Loctite #242 on the threads of each cradle pivot Allen bolt and using a 3/16" hex key, install the two cap screws into the U-bracket assembly.

2b. (480E)

Replace the slider blocks if they are worn. On one side, line up the slider block, angle bracket, and U-bracket and fasten them together with three of the cap screws passing through star washers. Repeat on the other side.

3. Slide the kneepot cable through both the top cover and the base frame.
4. Reinstall the kneepot cable (refer to section 4.2).

4.0 KNEEPOT (Potentiometer)

(480/480E/480E PRO)

4.1 Kneepot Cover

Note: Plastic rivets may be re-used if not damaged during removal.

Removal:

1. With a pair of diagonal cutters, carefully remove the rivets to free the kneepot cover.
2. Remove the kneepot cover.

Important: Remove center of kneepot rivet from casting by moving outer thigh tube so they fall out.

Installation:

1. Install the kneepot cover over the casting, aligning the cable with the small divot in the cover and the holes in the plastic with the holes in the casting.
2. Install the rivets in their appropriate holes and insert the plastic rivet centers.
3. With a small hammer gently tap the centers of the plastic kneepot rivets flush with the rivet casting.

4.2 Kneepot Cable

Removal:

1. Remove the bottom cover (refer to section 2.1).
2. Remove kneepot cover (refer to section 4.1).
3. Remove kneepot cable plug from the socket on the main PC board.
4. With diagonal cutters, remove all ty-raps from the kneepot cable.
5. Remove strain relief from top cover by removing the nut on the underside strain relief side of the top cover.
6. Pull cable through cover.
7. De-solder the cable from the terminals on the kneepot.

Installation:

1. Wrap wires one and one-quarter turns around kneepot terminals and solder as follows:
   480: pin #1 - white, pin #2 - red, pin #3 – black

   480E: pin #1 - black, pin #2 - red, pin #3 - white
2. Install kneepot cover (refer to section 4.1).
3. Carefully put kneepot cable through top cover. Feed the free end of the cable through the hole in the top cover until the cable strain relief is reached (only tighten the strain relief nut 1/4 turn past finger tight).
4. Put rubber washer on kneepot cable.
5. Install bottom strain relief nut on kneepot cable.
6. Tighten strain relief bottom nut 1/4 turn past finger tight.
7. Install the kneepot cable plug onto the main PC board connector pins 1, 2, 3.
8. Gather excess cable and secure to the front of the base frame with a ty-rap.
9. Install bottom cover (refer to section 2.1).

4.3 Knee Potentiometer (POT) Replacement

Removal:

1. Remove Knee Potentiometer cover (4.1).
2. De-solder wires from Potentiometer.
3. Insert the tip of a small screwdriver into the notch in the casting beside the Potentiometer and pry Potentiometer away from casting.
4. Retain Potentiometer Drive Coupling.

Installation:

1. Solder the Potentiometer cable wires to replacement Potentiometer if required. (See section 4.2)
2. Install the Potentiometer Drive Coupling end with the short slot into the casting. Make sure that the slot engages with the inside pin.

(Steps for 480/ 480E)

1. Enter calibration mode using the Calibration Procedure in section 11.1, steps 1 through 13. The motion controller screen will display “EXT [40-50] xx” where xx is a number indicating the angle the Potentiometer is currently at.
2. Gently insert the Potentiometer into the casting. The Potentiometer must be able to rotate in the casting. Make sure that the pin on the Potentiometer shaft enters the long slot end of the Potentiometer Drive Coupling.
3. Rotate the body of the Potentiometer until xx number on the controller screen is between 40 & 50.
4. Press the Potentiometer firmly into the casting until the shoulder of the Potentiometer contacts the casting. Confirm that the xx number on the controller screen is between 40 & 50.
5. Confirm that the Potentiometer is secure in the casting.
6. Proceed with steps 14 through 27 of the Calibration Procedure in Section 11.1.

(Steps for 480E PRO)

1. Switch the 480E PRO power on.
2. Gently insert the Potentiometer into the casting. The Potentiometer must be able to rotate in the casting. Make sure that the pin on the Potentiometer shaft enters the long slot of the Potentiometer Drive Coupling.
3. Rotate the Potentiometer body until the angle indicated on the Motion Controller is “0” degrees.
4. Press the Potentiometer body firmly into the casting until the shoulder of the Potentiometer contacts the casting. Confirm that the angle indicated on the Motion Controller is “0” degrees +/- 3 degrees.
5. Confirm that the Potentiometer is secure in the casting.
6. Proceed with the Calibration Procedure in Section 11.3.

5.0 MOTOR (480/480E/480E PRO)

Note: Transfer the ferrite loops to the new motor and install them in the same location on the cable.

Removal:

1. Remove bottom cover (refer to section 2.1).
2. Remove motor plug from main PC board in 480/480E (from Motor Board in 480E PRO) and pull connector through the hole in base frame.
3. Remove the four nuts from the rubber mounts inside the bearing bracket assembly.
4. Take the motor out of the assembly.
5. Remove the rubber coupling from either the motor or ball screw assembly.

Installation:

1. Insert the rubber coupling onto the end of the ballscrew bearing bracket assembly.
2. Place two internal star tooth washers on each of the rubber mounts (part number 13585 motors only).
3. Insert the four motor mount bolts through the base and into the mounting bracket and tighten nuts. (Take care not to twist the rubber mounts when tightening nuts.)
4. Reattach motor cables.
5. Reinstall the bottom cover.

6.0 BALLSCREW (480/480E/480E PRO)

Removal:

1. Remove bottom cover (refer to section 2.1).
2. Disconnect the motor and remove from the Bearing Bracket and Frame (refer to section 5).
3. Loosen the ballscrew nut.
4. Slide the U-bracket assembly to full extension.
5. Slide the motor mount end of the ballscrew into the corner of the frame and twist it into a vertical position while lifting the end of the ballscrew.

Installation:

1. Check to make sure that the plastic bearing for the ballscrew is located in its proper position. Then carefully place the ballscrew free end into the plastic bearing. Reverse step 5 above to replace the ballscrew.
2. Slide the motor mount end down into place. The four holes in the assembly should align with the frame holes.
3. Place the rubber mounts into the frame holes and through the motor mount, making sure that the washers are on the threaded side of the mounts.
4. Secure the ballscrew in place by screwing the rubber mount nuts on the inside of the motor mount on the end of each rubber mount and tightening.
5. Tighten the ballscrew nut (use Loctite #242).
6. Re-install the motor assembly.
7. Reinstall the bottom cover (refer to section 2.1).

7.0 POWER SUPPLY (480 ONLY)

Removal:

1. Remove bottom cover (refer to section 2.1).
2. Disconnect power supply cable connection from the power switch and the ground wire from the frame.
3. Carefully pull the power supply wires from the unit.

Installation:

1. Insert the power supply cable through the base frame.
2. Install the strain relief.
3. Re-connect and/or solder wires according to color codes.
4. Install tie-wraps as needed.
5. Reinstall bottom cover (refer to section 2.1).

8.0 MOTION CONTROLLER PENDANT (480/480E)

8.1 Controller Cable

Attention: The Motion Controller is a Static Sensitive Device. Repair should be attempted by qualified personnel only. All anti-static handling procedures should be observed.

Note: Transfer the ferrite loops to the new cable and install them in the same location. Ensure the cable and ferrite loops will not come in contact with any moving parts.

Removal (Steps 1 through 4 for 480 only):

1. Remove bottom cover (refer to section 2.1).
2. Cut ty-raps from the entire length of the controller cable, being careful not to damage the ribbon cable.
3. Pull the cable connector off the board-mounted connector.
4. Remove the strain relief and pull the cord through the base frame.

(Steps for both 480 and 480E):

1. Remove back cover label from controller.
2. Using a No. 2 Phillips screwdriver, remove the four screws from the back of the controller to open the controller housing.
3. Carefully pull the controller board straight away from the face of the controller housing.
4. Cut the ty-rap which holds the cable flat to the board.
5. Carefully slide cable connector from the board-mounted connector pins.

Installation:

1. Carefully slide cable connector onto the main controller board connector.
2. Position the cable so the shielded cable comes up over the edge of the controller board. Ty-rap the cable in place flat to the board.
3. Guide the pins from the controller keypad board into the connector on the main controller board. Carefully squeeze the two boards together until the connector is well seated.
4. Reinstall the back of the controller housing.
5. Reinstall the four Phillips screws and tighten.
6. Replace the back cover label.

(Steps 7-11 for 480 only)

7. Slide the board end of the cable through the opening in the base of the unit.
8. Re-position the strain relief.
9. Connect the cable to the board-mounted connector.
10. Join the controller and ribbon cables with ty-raps
11. Reinstall the bottom cover (refer to section 2.1).

8.2 Controller Keypad

Removal:

1. Remove back cover label from controller.
2. Using a No. 2 Phillips screwdriver, remove the four screws from the back of the controller.
3. Remove the back of the controller housing.
4. Carefully pull the control board straight away from the face of the controller housing.
5. Lift the board out of the controller housing.
6. Lift the LCD window out of the front half of the controller.
7. Using a 1/4” nut driver remove the four locknuts from the inside of the front half.
8. Carefully lift the controller housing away from the front bezel.
9. Lift out the controller control board to remove the keypad.

Installation:

1. Gently press keypad into position inside the bezel, checking to be sure that the locator pins have come through the pad.
2. Position the controller control board so that the locator pins also pass through the appropriate holes in the PC board.
3. Place the front controller housing on top of the bezel and control board assembly, and secure with four locknuts.
4. Place the LCD window into the opening, being sure that the printing is readable from the front of the controller.
5. Carefully position the main controller board in the front half of the controller housing.
6. Gently push the cable into the appropriate cutout in the housing.
7. Position the back controller housing making sure that the cable is not pinched between the two halves.
8. Install the four Phillips screws in the holes on the back of the controller and tighten.
9. Replace back cover label on back side of controller housing.

8.3 Controller Printed Circuit board

Removal:

1. Remove back cover label from controller.
2. Using a No. 2 Phillips head screwdriver, remove the four screws from the back of the controller.
3. Remove the back controller housing.
4. Carefully pull the controller board straight away from the front half of the controller housing.
5. Cut the ty-rap which holds the cable flat to the board.
6. Carefully slide cable connector from the board-mounted connector pins.
7. Lift the board out of the controller housing.

Installation:

1. Slide the cable connector onto the board-mounted connector pins.
2. Carefully insert the board into the front controller housing.
3. Gently push the cable into place in the cutout of the housing and tie-wrap the cable flat to the board.
4. Reinstall the back of the controller housing, making sure that the cable is not pinched between the two halves.
5. Reinstall the four Phillips head screws in the holes on the back of the controller and tighten.
6. Place back cover label on back side of controller housing.

9.0 PRO CONTROLLER PENDANT (480E PRO Only)

Attention: The PRO Controller Pendant is a Static Sensitive Device. Repair should be attempted by qualified personnel only. All anti-static handling procedures should be observed.

Note: It will be necessary to access the settings mode to access the systems setting service and error log. To enter the "settings mode" enter the following key sequence: Up Direction Arrow, Right Arrow, Down Arrow, Left Arrow, and Select.

9.1 Front Cover/Key Pad Replacement

Note: The Front Cover and Keypad (NG-SA001) is a single unit.

1. Remove all 4 screws from back of unit.
2. Pull off back and fish paper insulator.
3. Carefully remove front (which contains keypad); it is connected to the Printed Circuit Board (PCB) with a ZIF connector (REF DES J8).
4. Release Key Pad ribbon cable by retracting the 2 tabs on either side of the ZIF connector.

Note: The ribbon cable should release with minimal force.

9.2 Speaker Replacement

Remove Cover following steps 1 through 4 above.

5. Remove Top End Cap.
6. Carefully move LCD display out of the way.
7. Remove 2-lead connector on right hand side of board.
8. Remove Bottom End Cap and replace with new sub-assembly.
9. Reverse above order to put the PRO Controller back together.

9.3 Display Replacement

The Display is held in place by the top end cap and the bottom display holder.

To replace Display, first remove cover following steps 1 through 6 above.

10. Remove 20 pin Ribbon Cable from ZIF connector to remove display (REF DES J3).
11. Connect Ribbon Cable, insert Display into bottom display holder.

9.4 Battery Replacement for Real Time Clock

Follow steps 1 through 6 to remove speaker as described above. Once LCD Display is out of the way, simply slide the 3V Battery out of its retainer, and insert the new one. Reassemble in reverse order.

9.5 PCB Printed Circuit Board (PCB) or PCBA (Assembly)

Disassemble PRO Controller following steps 1 through 11 above.

1. Remove battery.
2. Remove bottom Display holder by removing the 2 screws.
3. Reattach all components to new board.
4. Reassemble front, back and end caps.

Note: When replacing cover, be careful not to damage Keypad ribbon cable.

10.0 MAIN PRINTED CIRCUIT BOARD (PCB)

10.1 Replacing PCB (480/480E)

Attention: The Printed Circuit Board is a Static Sensitive Device. Repair should be attempted by qualified personnel only. All anti-static handling procedures should be observed.

Removal:

1. Remove bottom cover of device (refer to section 2.1).
2. Remove all connectors from the main PC board.
3. The PC board may be removed by one of three procedures depending on when a particular device was manufactured:
   a. Gently push the PC board toward the top cover until the nylon standoff is disengaged from the board.
   b. Or, remove the nylon screws securing the PC board to the nylon standoffs.
   c. Or, remove the nylon nuts securing the Shield, insulator and PC board to the nylon standoffs. Lift the shield off.
4. Lift the insulator off.
5. Remove the four Spacers.
6. Lift the PC board from the standoffs.

Installation:

1. Place the main PC board above the nylon standoffs.
2. While guiding the nylon standoffs into the mounting holes, place the PC board on them.
3. To reinstall the PC board perform the following procedure (depending on when the device was manufactured):
   a. Gently push the PC board toward the bare frame until the PC board seats firmly against the stopping pad on the nylon standoff.
   b. Or, install the nylon screws securing the PC board to the nylon standoff.
   c. Or, place the PC board on to the four standoffs. Install the four Spacers on the standoffs. Place the insulator into the Shield. Place the Shield on to the standoffs and route the cables through the slots in the Shield. Position the ferrite loops as close to the Shield as possible and secure such that they do not contact any moving parts.

4. Install the connectors into main PC board.
5. Note: Cable connectors are installed on the following PCB connectors: Controller cord -J2, Kneepot Cable -J4-1,2.3, Power switch cord - J4- 4.5, Motor cord -J5
6. Reinstall bottom cover (refer to section 2.1)

10.2 Replacing PCB (480E PRO)

1. Remove bottom cover (see section 2.1)
2. Disconnect wire harnesses from PCB.
3. Remove the two screws that fasten the PCB.
4. Replace PCB. Reconnect the wire harnesses according to the printing on the PCB.
5. Replace the two screws.
6. Replace the bottom cover.

Note 1: The PCB is by default configured for the Maxon motor. For use with a Faulhaber motor, connect a pendant, switch the power on, and go to the Service Screen. Select "Set to 480e Maxon", use the up and down arrows to choose "Set to 480e Faulhaber", and press Select to save the change. Wait for the system to turn itself off and on.

Note 2: The system will need to be recalibrated, see section 11.3.

Note 3: Go to the System Settings screen. If the System Hours are not 0, go to the Service Screen and select "Zero Mtr Hrs".

11.0 CALIBRATION

11.1 Calibration (480/480E)

Attention: The Printed Circuit Board is a Static Sensitive Device. Repair should be attempted by qualified personnel only. All anti-static handling procedures should be observed.

1. The calibration jumper must be in place during initial start-up. After machine calibration is complete, remove the calibration jumper.
2. Do not remove the EEPROM from the printed circuit board. The printed circuit board is designed for use only with the latest revision of firmware loaded into the EEPROM installed by the factory.
3. Thoroughly test all machine functions and test run the machine a minimum of two (2) hours prior to patient use.

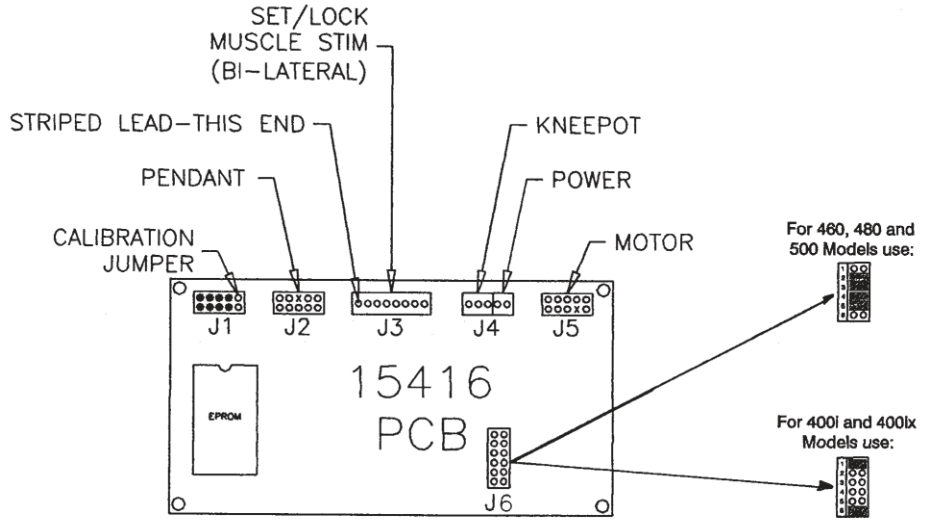
Procedure:

1. Turn off CPM.
2. Remove bottom cover (refer to section 2.1).
3. Lay the unit on its side.
4. Make sure all connectors are connected.
5. Install calibration jumper on the PC board on J1 at CTE.
6. Turn power on.
7. If the error code screen is displayed record the error codes. Fix error before calibration and re-power base to clear error.
8. Press Start/Stop to clear error codes.
9. Choose machine model using arrow keys.
10. Press Start/Stop.
11. When screen displays motor type, press Start/Stop.
12. Remove cradle from thigh assembly
13. Hold the kneepot side cradle at zero degrees (straight), using calibration fixture.
14. Press EXT.
15. Hold the kneepot side cradle at 90 degrees (right angle) using calibration fixture.
16. Press FLEX.

17. Hold kneepot side cradle at maximum extension.
18. Press EXT.
19. Hold kneepot side cradle at maximum flexion
20. Press FLEX.
21. Lay unit flat.
22. Reassemble the cradle.
23. Press Start/Stop.
24. The machine will run through a complete cycle. Note: if the screen displays "Binding" this indicates excessive current draw by the motor, caused by excessive friction in the drive chain or a problem with the motor. Resolve the problem and repeat the calibration procedure.
25. When the screen displays “CAL COMPLETE” turn power off.
26. Remove the calibration jumper.
27. Reassemble unit.

11.2 Calibration Diagram (480/480E)

Fig 2



11.3 Calibration (480E PRO)

If the motor, Potentiometer, Lead Screw or the Base Unit Actuator PCB have been replaced, the device will need to be recalibrated.

Minimum and Maximum thigh extension limits, as well as 0° and 90° settings, will also need to be calibrated. Screen prompts in the PRO Controller will lead you through the process.

To Calibrate:

Once the device has been turned on, go to the Setting Mode in the PRO Controller and enter the following special key sequence using the soft keys and the select button (soft key 4, right directional key, soft key 4, right directional key, select). (Fig. BELOW). Two new blank tabs will appear. To calibrate, go to the leftmost new tab, and select the button marked 'calibrate', and follow the on-screen prompts.

Fig 3

Operating Screen with functional elements called out.

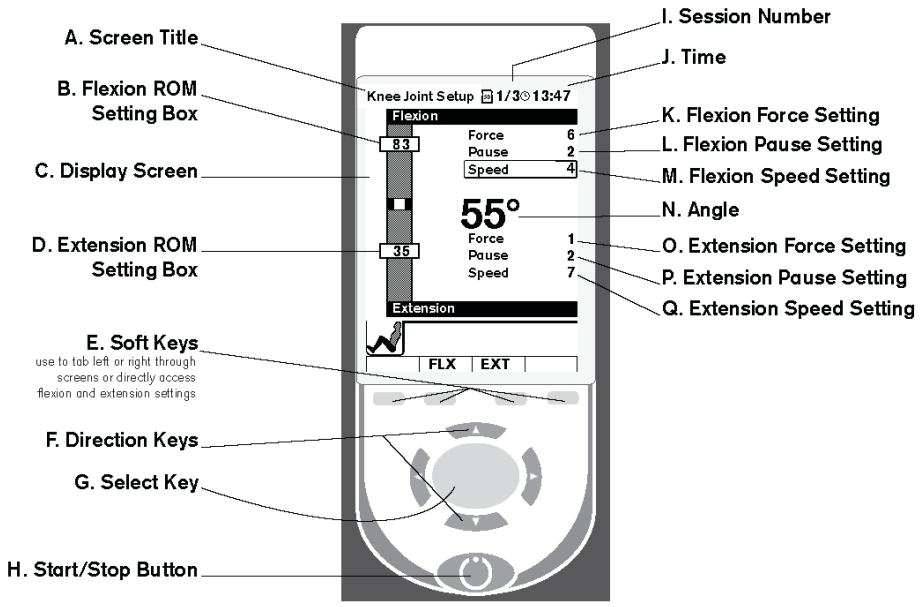


Fig. 3 Overview of PRO Controller Pendant controls.

At the bottom of the screen you will see “Calibrate” button that can be highlighted using the Direction Keys and Selected with the Select button.

The PRO Controller will lead you through the steps necessary for the following calibrations:

- 0° Calibration
- 90° Calibration
- Maximum thigh extension
- Minimum thigh extension

For 0° Calibration: Remove cradle from thigh assembly and apply 0° calibration fixture, following steps in PRO Controller.

For 90° Calibration: Remove cradle from thigh assembly and apply 90°calibration fixture, following steps in PRO Controller.

For minimum thigh extension, make sure the thigh cradle is in place and that the calibration jig has been removed.

For maximum thigh extension, make sure the thigh cradle is in place and that the calibration jig has been removed.

When you are finished with the calibration, restart the device.

12.0 ERROR CODES

12.1 Error Codes (480/480E)

Important: Errors are handled on a case by case basis. Detection of some errors stops the CPM. At that time it will display an error code. It then burns the associated error code into the EE-ERROR byte in EEPROM. For other lesser errors the only action taken is to burn the code into EEPROM. The specific actions of each error are detailed in the following text. The EE-ERROR byte is reset by getting into the calibration mode. Refer to section 10.0 for further instructions.

[E1]: KNEE PIVOT ANGLE CALIBRATION ERROR

Error Action: This error prevents the CPM from entering the run mode.
Display: CALIBRATE [E1]
Cause: An invalid knee pivot angle calibration is indicated by bit 0 of EE_CAL_STATUS being zero.
Corrective Action: Re-calibrate the unit.

[E2]: MECHANICAL LIMIT CHECK OR FORCE CHECK VALIDATION ERROR

Error Action: See Display
Display: CALIBRATE [<-]
Cause: The extension limit check, the flexion limit check of the force check was not fully executed. This action occurs when the unit is calibrated.
Corrective Action: Re-calibrate the unit.

[E3]: EE EXT CAL OR EE FLEX CAL EEPROM VARIABLE ERROR

Error Action: This error prevents the CPM from entering the run mode.
Display: CALIBRATE [E3]
Cause: On power-up the microcontroller checks the values of EE_EXT_CAL and EE_FLEX_CAL. Limits are imposed on the value of these variables at calibration. If the values read from EEPROM are not within these limits the variable is assumed to be corrupted and an error is generated.
Corrective Action: Re-calibrate the unit.

[E4]: SOFTWARE TIMER ERROR

Error Action: This error causes the microcontroller to burn 4 in the EE_ERROR EEPROM.
Display: *****STOP*****
Cause: A software variable called Timer Overflow Interrupt
Count (T01 Count) is incremented every time the timer overflows. After the value of the T01 Count becomes greater than 2746 the timer value in EEP ROM is incremented and the 2746 is subtracted from T01 Count. If for some reason this process fails and T01 Count becomes greater than 32000 Error 4 is generated.
Corrective Action: Contact the Technical Service Department and inform them of the error. The main PCB may need to be replaced.

[E5]: MOTOR SPEED MEASUREMENT ERROR

Error Action: This error causes the microcontroller to burn 5 in the EE_ERROR EEPROM and causes the CPM to stop.
Display: *****STOP*****
Cause: With every revolution of the motor the MC33039 detects when the sensor in the motor makes a transition. That is when the sensor goes from high to low or low to high. It generates a pulse of fixed width. The microcontroller measures the speed of the motor by counting the number of pulses that occur in one timer overflow period. This happens in 131 seconds. When the unit runs too fast (over 230 RPM)

the time between sensor transitions becomes less than the pulse width. The microcontroller counts 0 pulses therefore the speed measured=0 even though the motor is revolving.
Corrective Action: Troubleshoot PCB. MC33039 OSC Resistor-Capacitor combination may be out of tolerance.
There can be excessive noise on the Hall Effect sensor inputs, a bad MC33039, a bad microcontroller, etc. Reset EE_ERROR byte by entering the calibration routine.

[E6]: EEPROM INITIALIZATION ERROR

Error action: This error prevents the CPM from entering the run mode.
Display: EEPROM ERR [E6]
Cause: During initial calibration certain variables in EEPROM are initialized. If there is some problem and one of these variables cannot be written to EEPROM, Error 6 is generated.
Corrective Action: If the problem recurs replace the microcontroller or the PCB.

[E7]: CYCLE COUNTER ERROR

Error Action: This error causes the microcontroller to burn 7 in the EE_ERROR EEPROM.
Display: *****STOP*****
Cause: Every time the unit pauses in extension a variable in the software called cycles since save is incremented. Every six minutes of operation the timer is incremented and the total cycle count is increased by the cycles since save, after which cycles since save is zeroed. If this process goes awry and cycles since save becomes greater than 500, Error 7 is generated.
Corrective Action: Contact the Technical Service Department and inform them of the error. The main PCB may need to be replaced.

[E8]: MOTOR SPEED ERROR

Error Action: This error causes the microcontroller to burn 8 in the EE_ERROR EEPROM and causes the CPM to stop.
Display: *****STOP*****
Cause: The maximum CPM rpms is less than 200. If the speed measured is greater than 254 counts in one timer overflow (roughly 500 rpm) then error 8 is generated.
Corrective Action: Troubleshoot PCB. MC33039 OSC Resistor-Capacitor combination may be out of tolerance. There can be excessive noise on the Hall Effect sensor inputs, a bad MC33039, a bad microcontroller, etc. Reset EE_ERROR byte by entering the calibration routine.

[E9]: START/STOP ERROR

Error Action: This error causes the microcontroller to burn 9 in the EE_ERROR EEPROM and causes the CPM to stop.
Display: *****WAIT*****
Cause: The microcontroller has detected that the START/STOP key was depressed for more than 16.4 seconds. The START/STOP on the main or auxiliary controller may have been depressed for that period. The PCC (Patient Control Cord) may have an open circuit. The main controller may have a short circuit. It is normally open.
Corrective Action: Troubleshoot the controller and the main PCB. Reset EE_ERROR byte by entering the calibration routine.

[E10]: KNEEPOT WIPER VOLTAGE TOO LOW

Error Action: This error causes the microcontroller to burn 10 in the EE_ERROR EEPROM and causes the CPM to stop.
Display: ANGLE ERROR [E10]
Cause: The kneepot wiper or +8v may have an open. The main PCB may have a problem.
Corrective Action: Examine the kneepot, the kneepot cable and kneepot connector for possible opens and troubleshoot the main PCB. Perform the extension limit check in the calibration mode to assure that the cradle is not traveling outside the kneepot's voltage range. Reset EE_ERROR byte by entering the calibration routine.

[E11]: KNEEPOT WIPER VOLTAGE TOO HIGH

Error Action: This error causes the microcontroller to burn 11 in the EE_ERROR EEPROM and causes the unit to stop.
Display: ANGLE ERROR [E11]
Cause: The problem may be in the main PCB or the kneepot ground may have an open.
Corrective Action: Examine the kneepot, the kneepot cable and kneepot connector for possible opens and troubleshoot the main PCB. Perform the extension limit check in the calibration mode to assure that the cradle is not traveling outside the kneepot's voltage range. Reset EE_ERROR byte by entering the calibration routine (refer to section 10.0).

[E12]: Not used in the Model 480

[E13]: EEPROM VARIABLE ALLOCATION ERROR

Error Action: This causes the microcontroller to burn 13 in the EE_ERROR EEPROM.
Display: *****STOP*****
Cause: Each variable, in software, has a predetermined amount of EEPROM dedicated to it. The reason being is that each byte of EEPROM can be written to only a finite number of times. Upon copying a variable to EEP ROM the microcontroller checks that the copy matches the original. If it does not match it goes on to the next byte of EEPROM and tries to write it again. Eventually there may come a time when the variable runs out of the EEPROM that was allocated for it. This generates an error 13.
Corrective Action: Contact QAL Medical Customer Service Department and inform them of the error. The main PCB may need to be replaced. (There is enough EEPROM allocated for each variable to last for more than a decade of constant use.)

[E14]: EEPROM POINTER ALLOCATION ERROR

Error Action: This causes the microcontroller to burn 14 in the EE_ERROR EEPROM.
Display:*****STOP*****
Cause: Each variable, in software, has a predetermined amount of EEPROM dedicated to it. The reason being is that each byte of EEPROM can be written to only a finite number of times. Upon copying a variable to EEP ROM the microcontroller checks that the copy matches the original. If it does not match an "EEPROM pointer" byte is incremented so the microcontroller is directed to the next byte of EEPROM. It proceeds to write the variable again. However, if the EEPROM pointer, a byte of EEPROM, cannot be incremented, an error 14 is generated. The variable cannot be written to the EEPROM correctly.
Corrective Action: Contact the Technical Service Department and inform them of the error. The main PCB may need to be replaced.

[E15]: KNEEPOT WIPER VOLTAGE NOT CHANGING QUICKLY ENOUGH

Error Action: This causes the microcontroller to burn 15 in the EE_ERROR EEPROM and causes the CPM to stop.

Display: *****STOP*****

Cause: If the CPM is in the run mode and the A/D converter reading doesn't change by more than two counts in a short, pre-determined amount of time, an error 15 is generated. The problem could be due to a faulty kneepot or kneepot cable.

Corrective Action: Check for a faulty kneepot or kneepot cable. Reset EE_ERROR byte by entering the calibration routine.

[E16]: CONFIGURATION ERROR

Error Action: This error prevents the CPM from entering the run mode.

Display: EEPROM ERR [E16]

Cause: The CONFIG register is latched on power-up from a CONFIG byte in EEPROM located at the same address. The CONFIG register configures the microcontroller. The EEPROM CONFIG is burned each time the micro controller is put through calibration. If for some reason the CONFIG is not equal to the correct value, an error 16 is generated.

Corrective Action: Reset EE_ERROR byte by performing the calibration routine. If the problem persists the main PCB may need to be replaced.

[E17]: TOO MANY FORCE REVERSALS

Error Action: This error causes the microcontroller to burn 17 in the EE_ERROR EEPROM and causes the CPM to stop.

Display: *****STOP*****

Cause: If the unit has seven force reversals in a 30 second period an error 17 will be generated.

Corrective Action: With the unit traveling, look for binding in the unit. Reset EE_ERROR byte by entering the calibration routine.

[E18]: INVALID EE MOTOR TYPE

Error Action: This error causes the CPM to exit the run mode.

Display: CALIBRATE [E18]

Cause: Calibration includes a motor type selection. If the EE_MOTOR_TYPE is found to contain something other than the correct selection an error 18 is generated.

Corrective Action: In the calibration mode re-select the motor type. If the error persists, contact the Technical Service Department.

[E19]: INVALID EE MODEL TYPE

Error Action: This error causes the CPM to exit the run mode.

Display: CALIBRATE [E19]

Cause: Calibration includes a model type selection. If the EE_MODEL_TYPE is found to contain something other than the correct selection an error 19 is generated.

Corrective Action: In the calibration mode re-select the model type. If the error persists, contact the Technical Service Department.

[E20]: FIRMWARE CHECHSUN ERROR

Error Action: This error prevents the CPM from entering the run mode.
Display: CHECKSUM ERROR [E20]
Cause: The Firmware in the EEPROM has become corrupted.
Corrective Action: Replace the PCB Assembly and the EEPROM.

[E21]: KNEEPOT VOLTAGE NOT CHANGING FAST ENOUGH

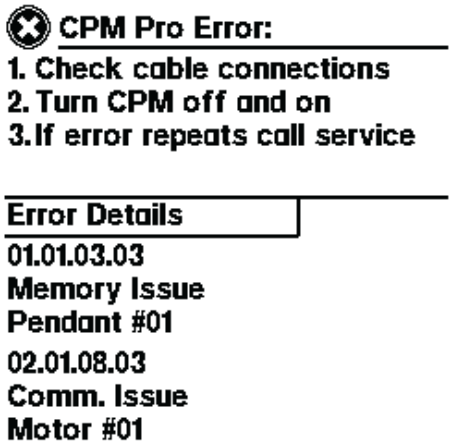
Error Action: This error causes the CPM to exit the run mode.
Display: ERROR 21
Cause: If the CPM is in the run mode and the A/D converter reading does not change by more than two counts in a short, pre-determined amount of time, an error 21 is generated. The problem could be due to a faulty kneepot or kneepot cable.
Corrective Action: Check for a faulty kneepot or kneepot cable and replace. Re-start the unit by turning the power off and then on. This error code is not burned into the EE_ERROR EEPROM

[E23]: EEprom has not been updated.

If this occurs on 3 or more consecutive cycles, replace PCB Assy.

12.2 Error Codes (480E PRO)

If an error occurs in the PRO Controller, a pop-up window will appear with the error code. A list of all error codes appears below.



Error Code Table with Repair Steps

Error ID	Error Desc.	Repair Steps
01.01.01.00	Keypad	Keypad failure, replace keypad
01.01.03.xx	Memory Error	Reset machine, replace pendant
01.01.04.00	RTC Error	Reset machine, if persists, replace pendant
02.01.02.xx	Leading Pot	Reset machine, repair/replace pot, replace motor board
02.01.03.00	Raw pot value too large	
02.01.04.00	Raw pot value too low	
02.01.05.00	Hall Error	reset machine, replace motor, replace motor board
02.01.07.00	Actuator EEPROM Error	reset machine, replace motor board
02.01.08.xx	Communication Error	reset machine, replace cables, replace motor board, replace pendant PCB
02.01.09.00	Too Many ROL's	reset machine, replace motor board, replace motor
02.01.10.01	Heartbeat Lost	reset machine, replace cables, replace motor board, replace pendant PCB

13.0 Troubleshooting

13.1 Troubleshooting (480/480E Only)

PROBLEM	POSSIBLE CAUSE	FIX
Unit will not power up	No voltage to Main PCB	Replace Power Supply
Unit does not beep	No voltage to Main PCB	Replace Switch
	Main PCB failure	Replace PCB
	Controller cable	Check controller cable
	disconnected connections	at both ends
		Return for service
Controller, erratic display	Controller cable break	Replace cable
	Controller PCB failure	
	Main PCB failure	Replace PCB
	Poor connection at	Check for faulty ribbon
	ribbon cable cable	Return for service
Error codes:	Out of calibration	Re-calibrate unit following
E1,2,3,4,6,7,8,12,13,14,15,16,18		calibration procedures
	Main PCB failure	Replace PCB
	Controller cable break	Replace Controller cable
	Controller PCB failure	Replace Controller
		Return for service
Error code E9	Calibration error	Re-calibrate following
		calibration procedures
	Controller cable break	Replace Controller cable
	Controller PCB failure	Replace Controller
		Return for service
Error codes E10,11	Knee pot cable break	Replace Knee Pot cable
	Knee pot	Replace Knee Pot
		Return for service
Error code E20	Main PCB failure	Replace PCB
		Return for service
Mechanical binding/jerking	Insufficient lubrication on track,	Use a Light Lithium
	ballscrew, and track seals	based lubricant, Lubriplate #105
		on tracks and ballscrews, and a
		Silicone spray on track seals
	Bearing bracket assembly failure	Replace bearing bracket
		Assembly
	Ballscrew failure	Replace Ball Screw
		Assembly
	U-Bracket/Slider Assembly failure	Replace U-bracket/Slider
		Assembly Bracket
		Assembly
	Motor failure	Replace Motor
		Return for service
Insufficient lifting power	Motor failure	Replace motor
		Return for service

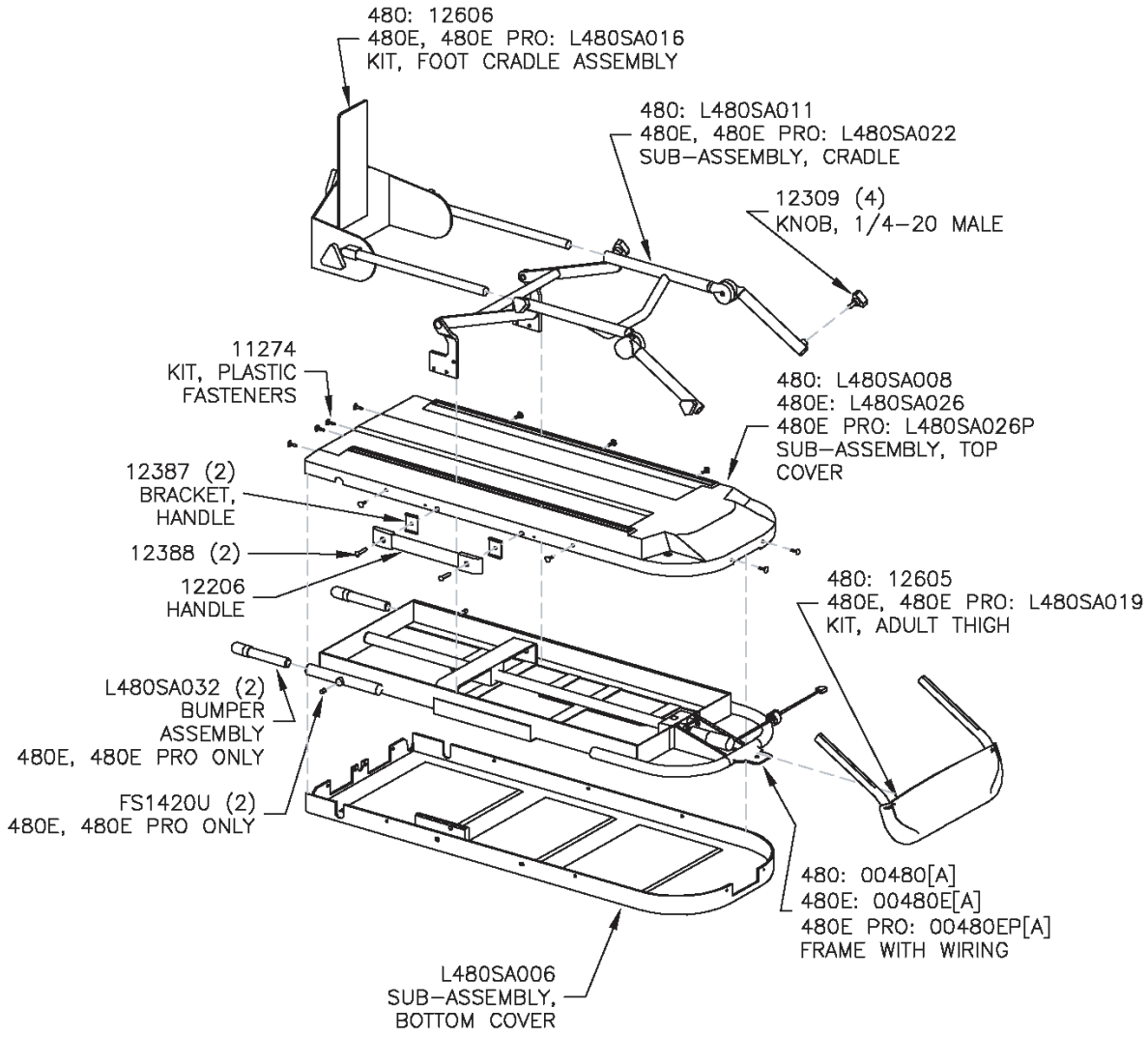
13.2 Troubleshooting (480E PRO Only)

PROBLEM	POSSIBLE CAUSE	FIX
Unit will not power up	No voltage to Unit	Replace Power Supply
Unit does not beep	No voltage to Unit	Replace Switch
	Pendant failure	Replace Pendant
		Check pendant cable
		at both ends
		Return for service
Pendant, erratic display	Pendant failure	Replace Pendant
	Damaged Display	Replace Pendant Display
Mechanical binding/jerking	Insufficient lubrication on track,	Use a Light Lithium
	ballscrew, and track seals	based lubricant, Lubriplate #105
		on tracks and ballscrews, and a
		Silicone spray on track seals
	Bearing bracket assembly failure	Replace bearing bracket
		Assembly
	Ballscrew failure	Replace Ball Screw
		Assembly
	U-Bracket/Slider Assembly failure	Replace U-bracket/Slider
		Assembly Bracket
		Assembly
	Motor failure	Replace Motor
		Return for service
Insufficient lifting power	Check that return on load (ROL)	Increase force setting with
	setting is sufficient	pendant controller

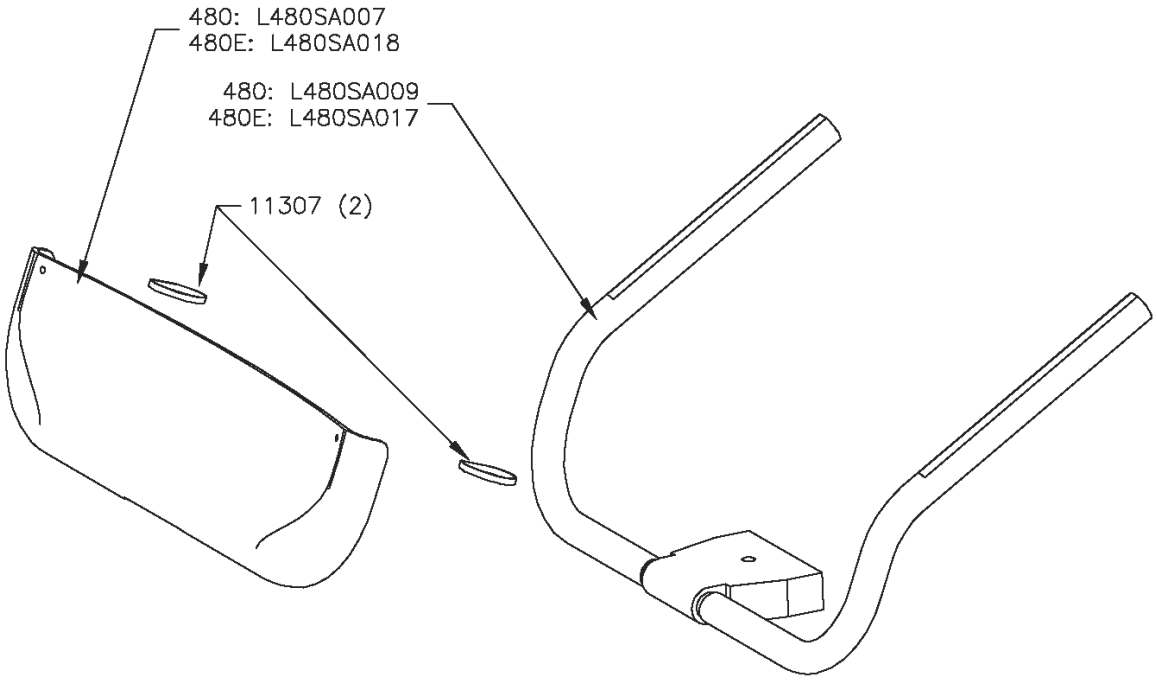
Note: For error codes see error codes in section 12.2.

14.0 Assembly Drawings

14.1 Main Assembly



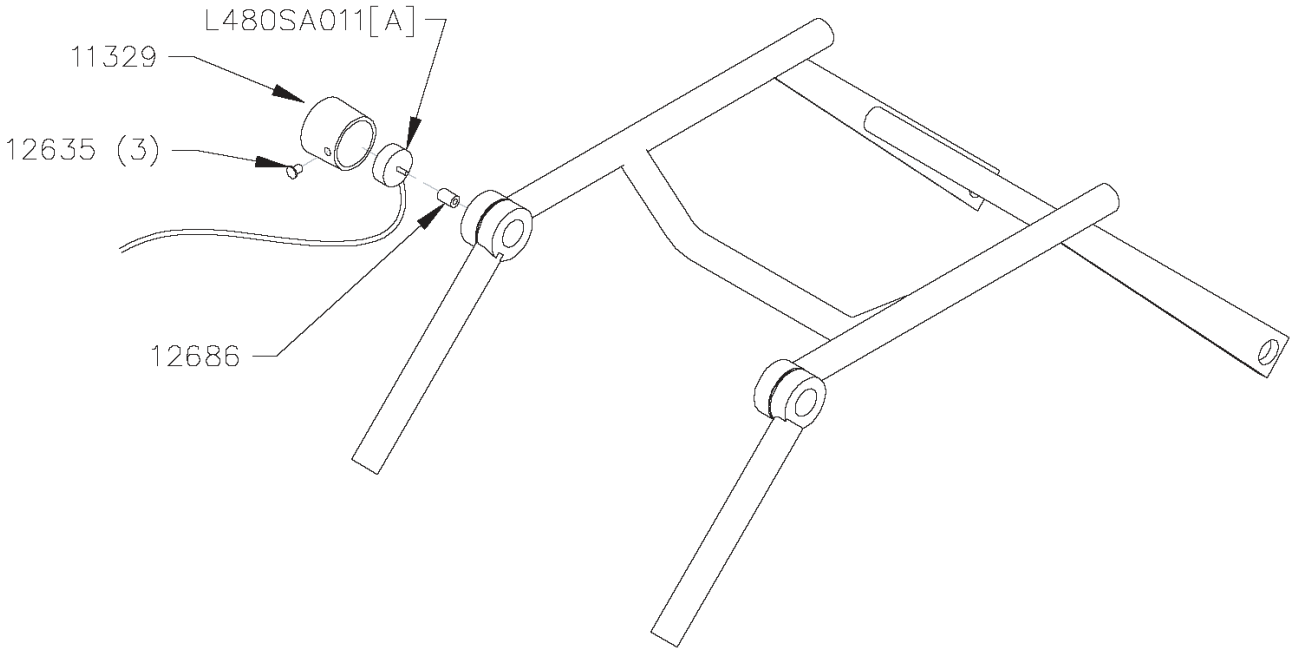
14.2 Thigh Assembly



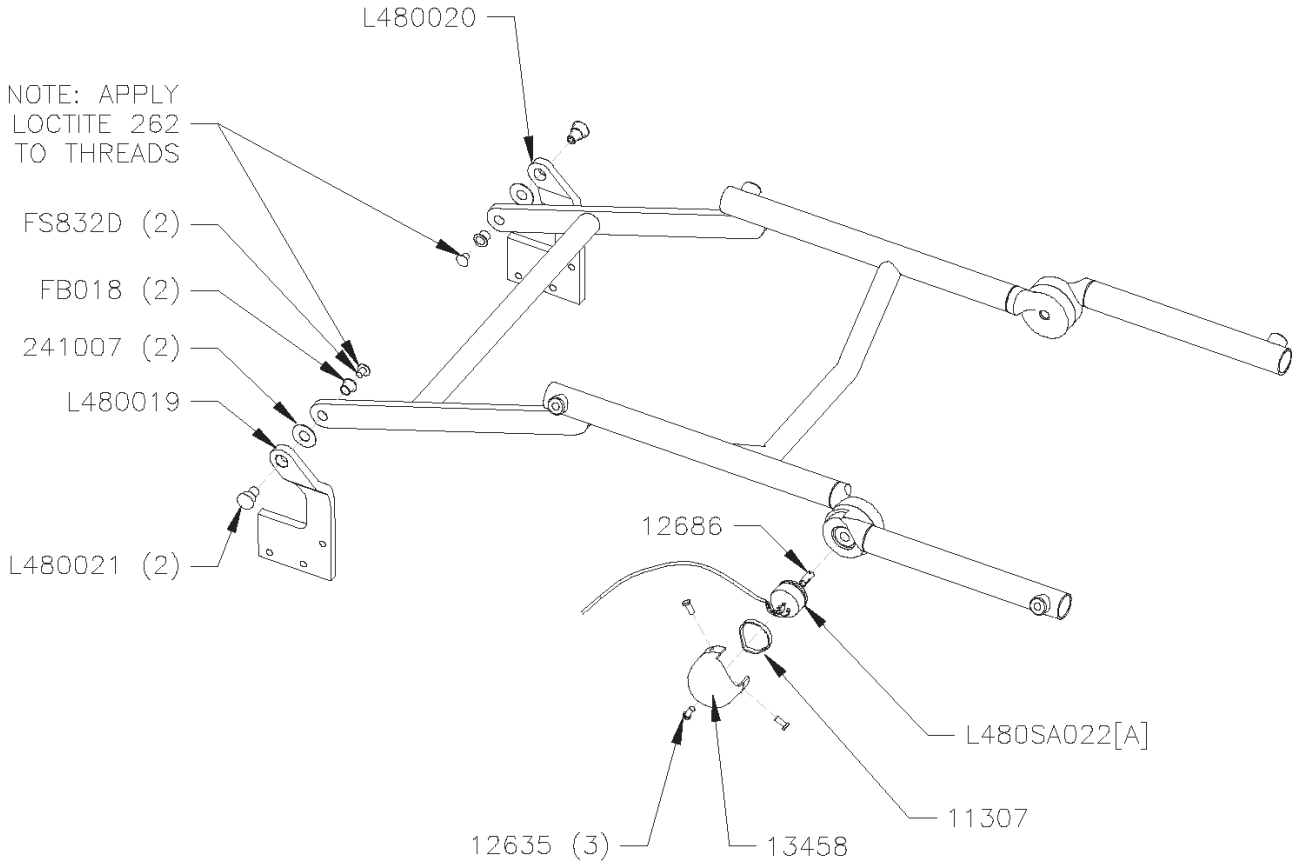
480: 12605; KIT ADULT THIGH ASSEMBLY
480E, 480E PRO: L480SA019; KIT THIGH ASSEMBLY 480E STANDARD

14.3 Cradle Sub-assembly

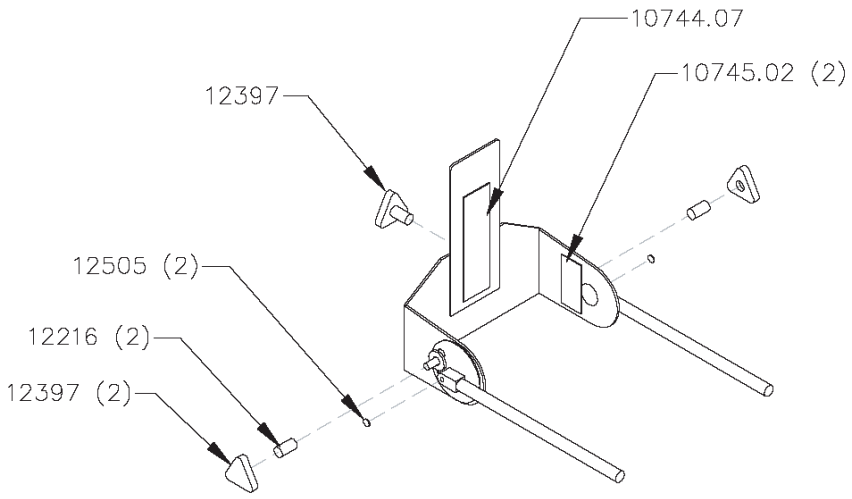
480 = L480SA011



480E = L480SA022

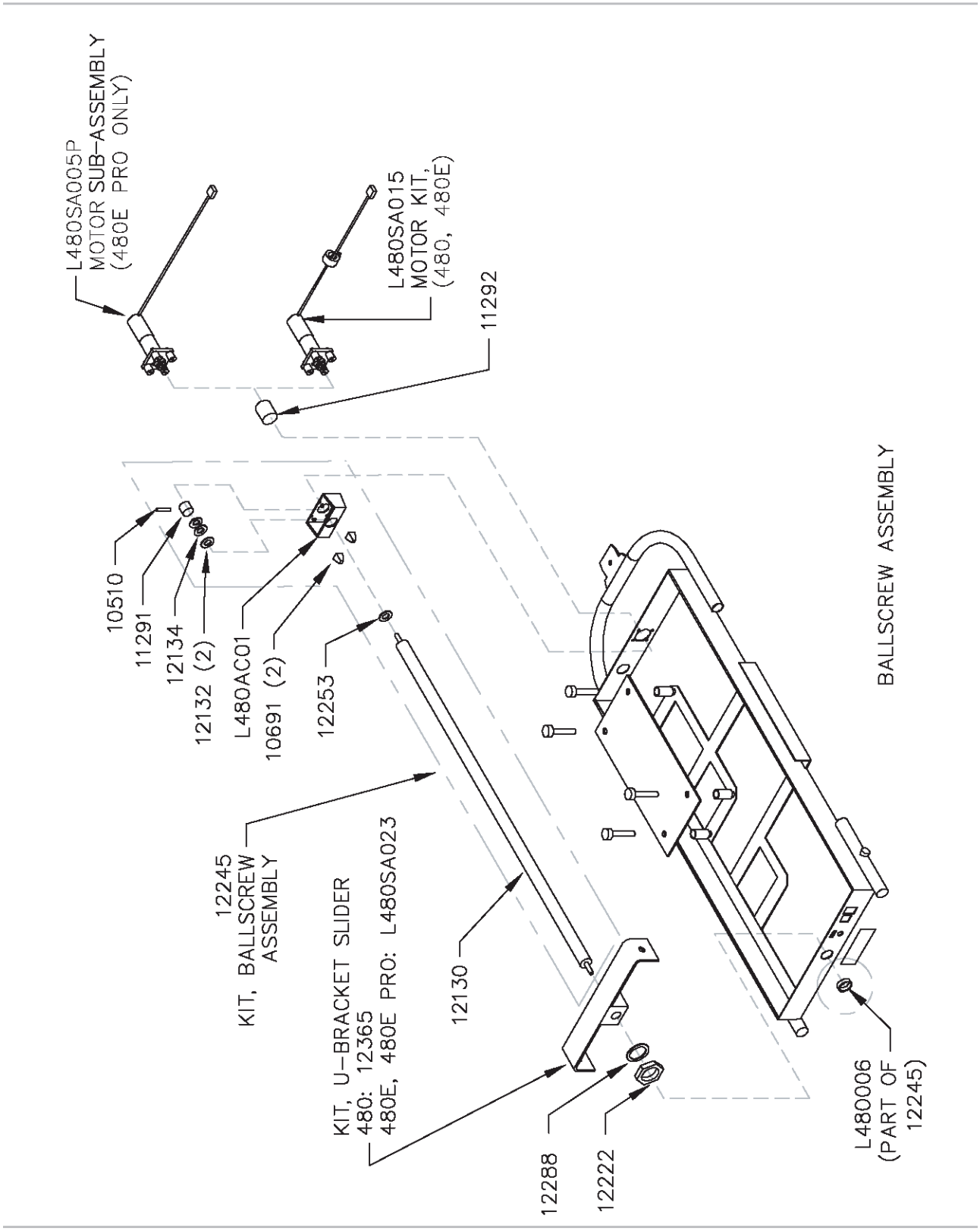


14.4 Foot Cradle Assembly

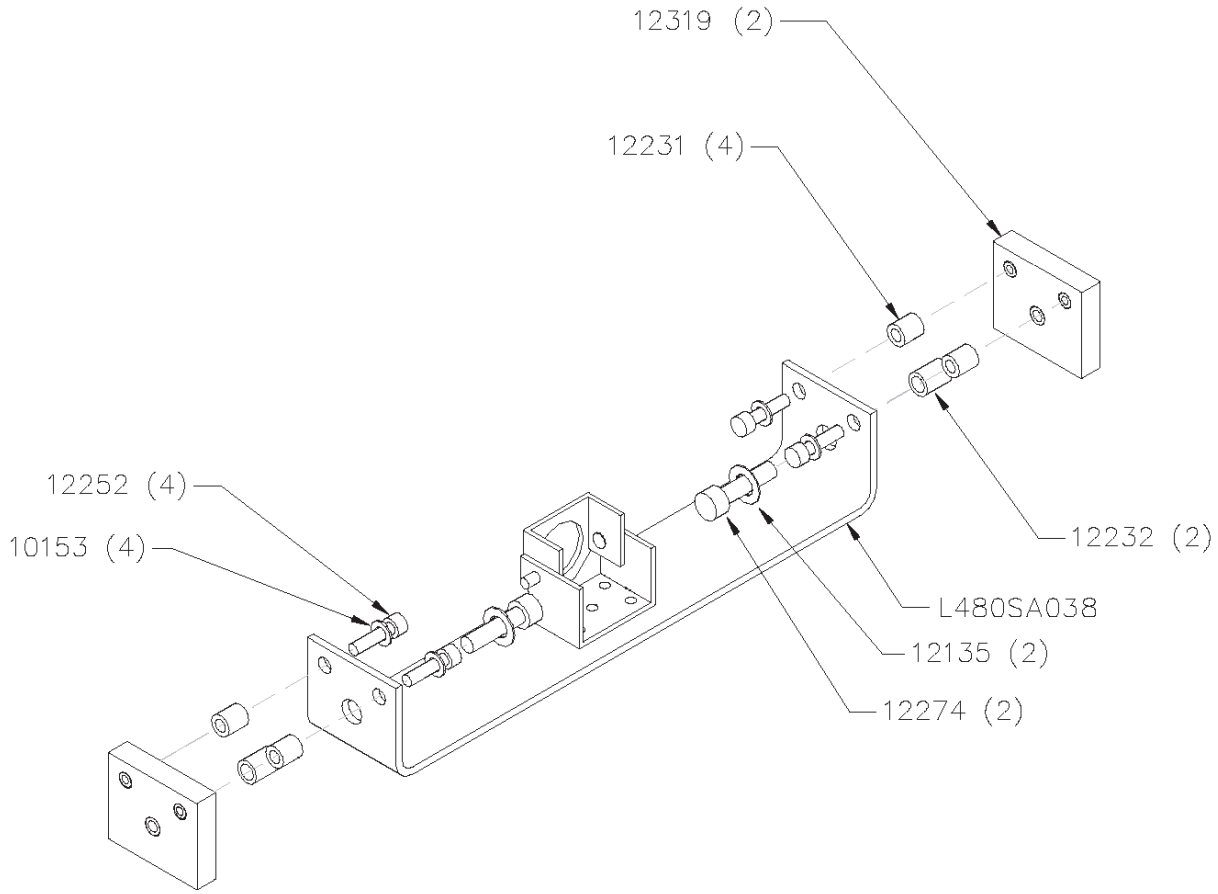


12606; Kit, Adult Foot Assembly – 400 Series
L480SA016; FOOT CRADLE ASSEMBLY 480E, 480E PRO

14.5 Ballscrew Assembly

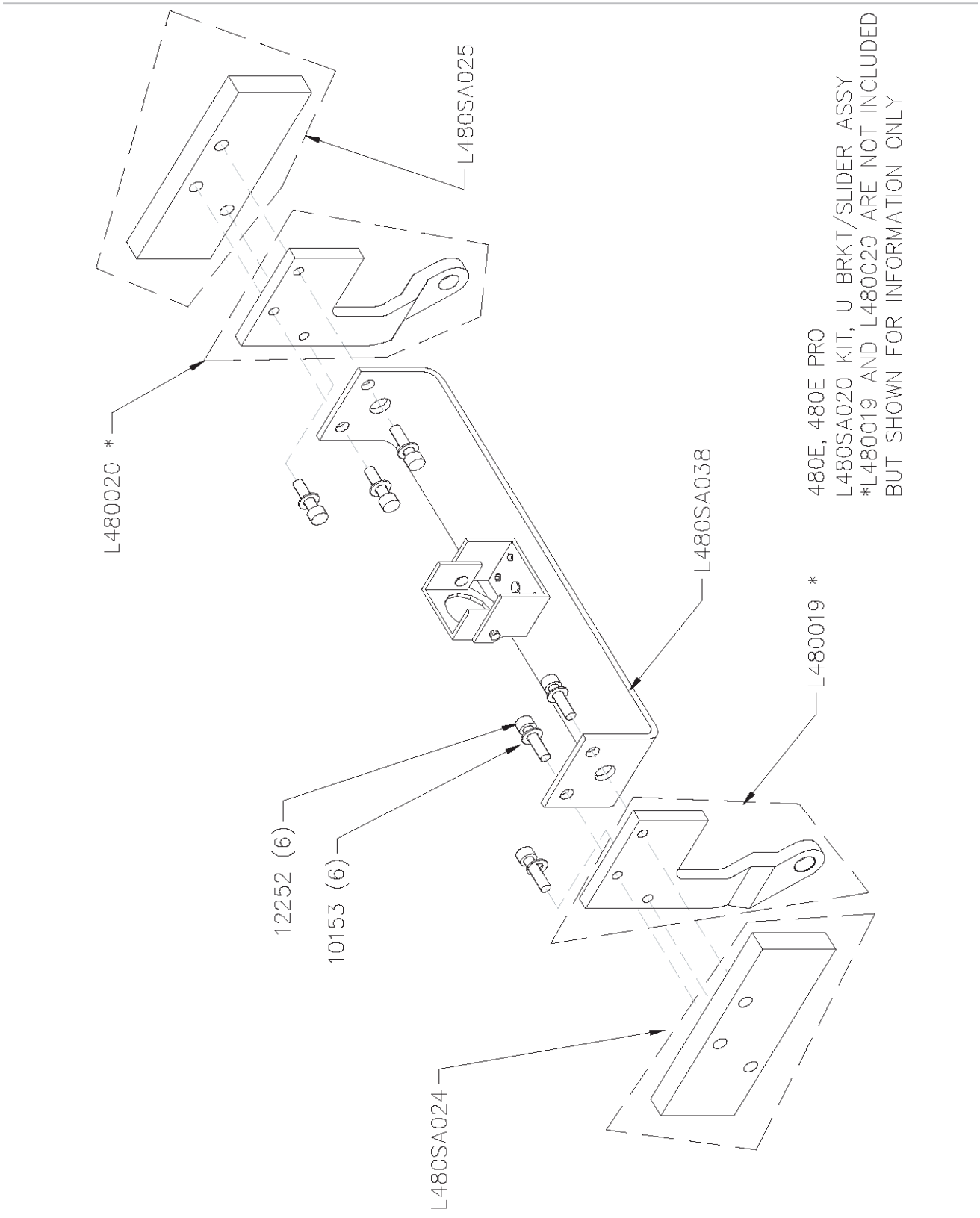


14.6 480 U-Bracket/Slider Assembly

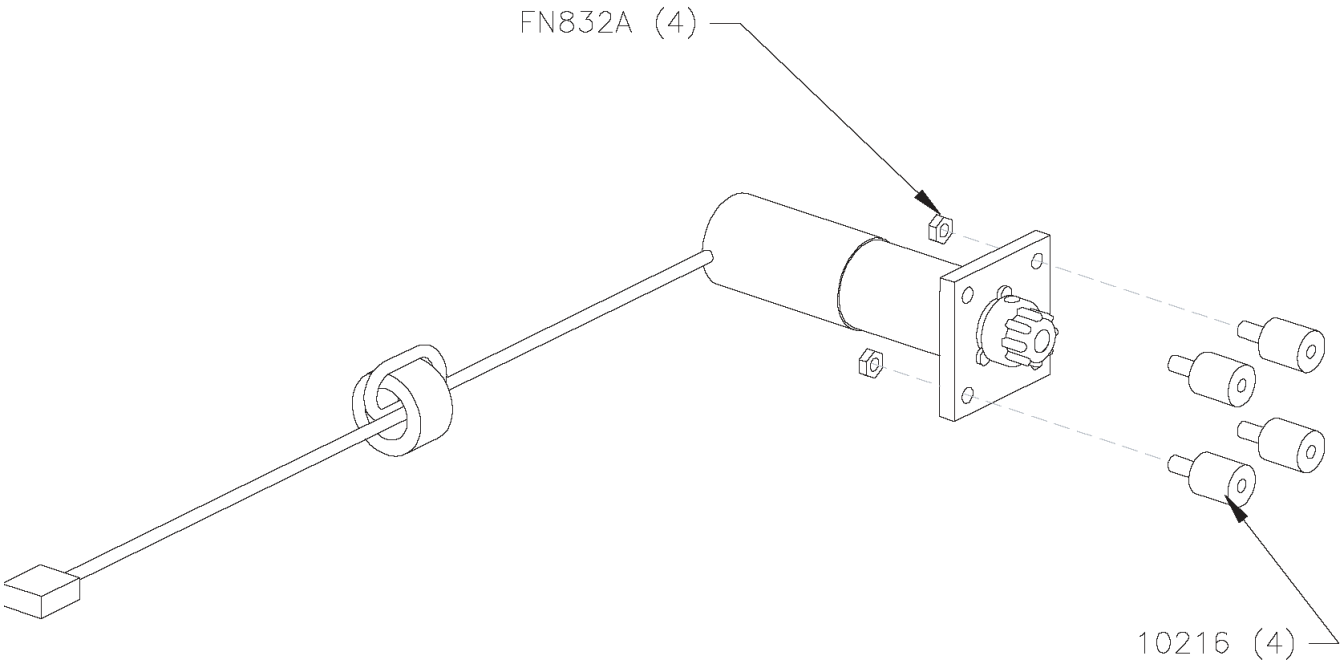


480
12319; Kit, Slider Block Assembly
12365; Kit, U–Bracket / Slider Assembly Complete

14.7 480E/480E PRO U-Bracket/Slider Assembly

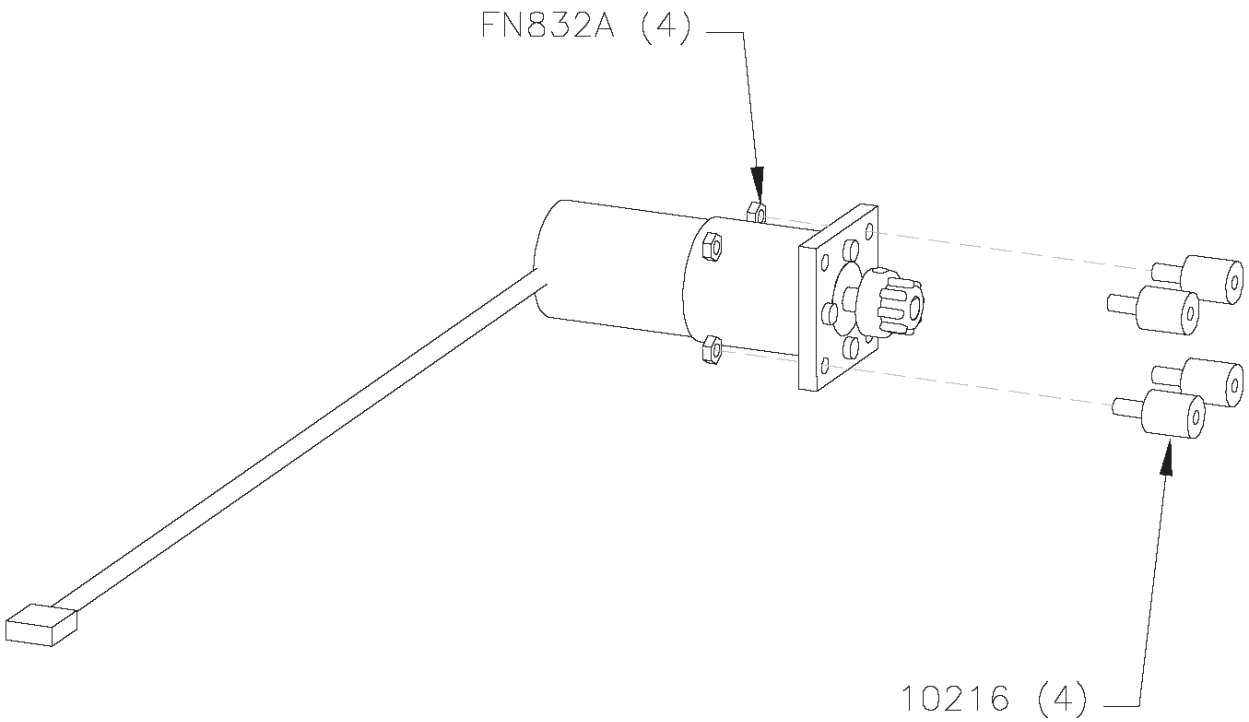


14.8 480E (or 480E PRO) Motor Assembly (Faulhaber)



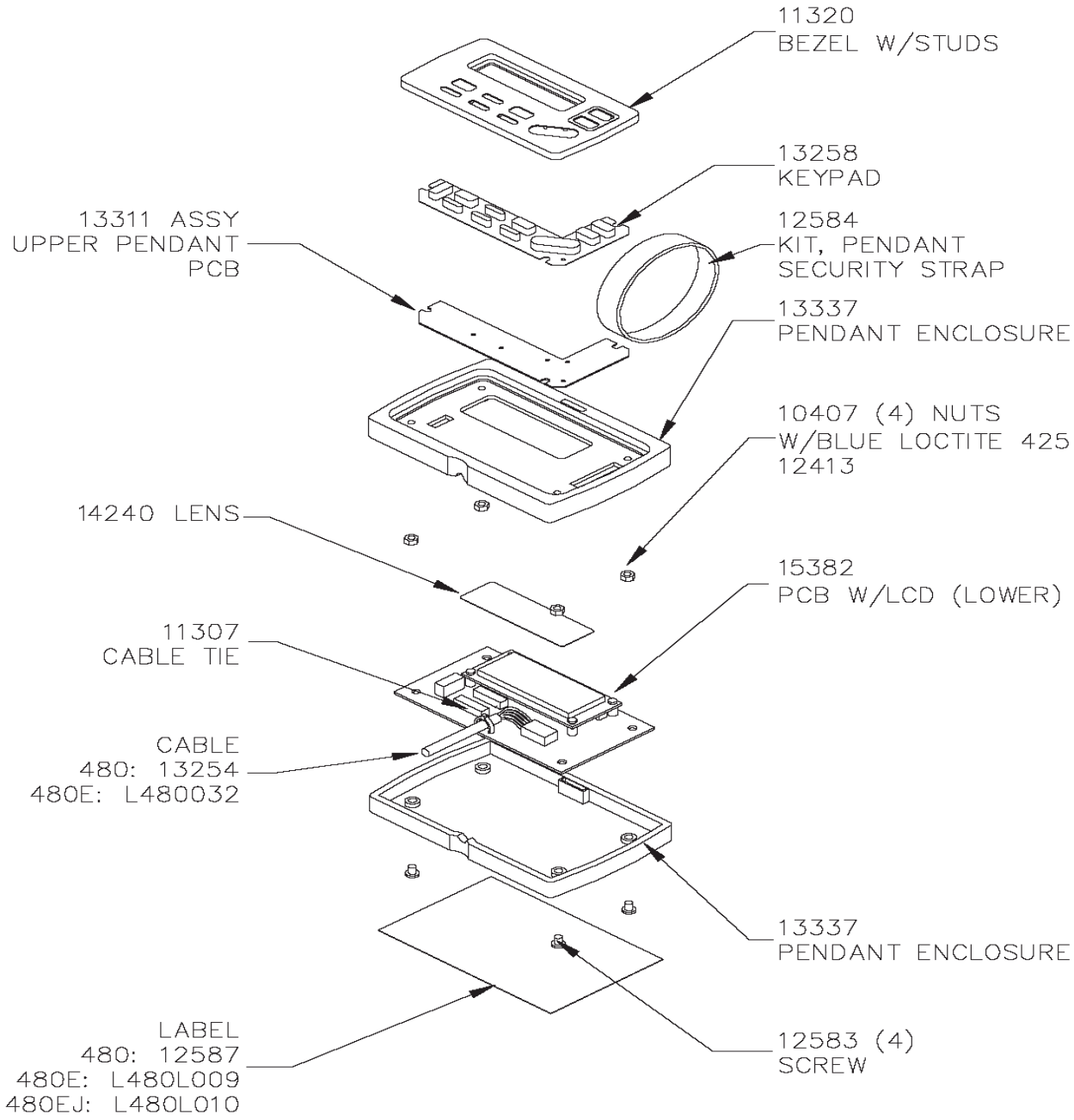
L480SA015; MOTOR KIT
SERIAL NUMBERS 480-05332 AND HIGHER

14.9 480E PRO ONLY Motor Assembly (Maxon)

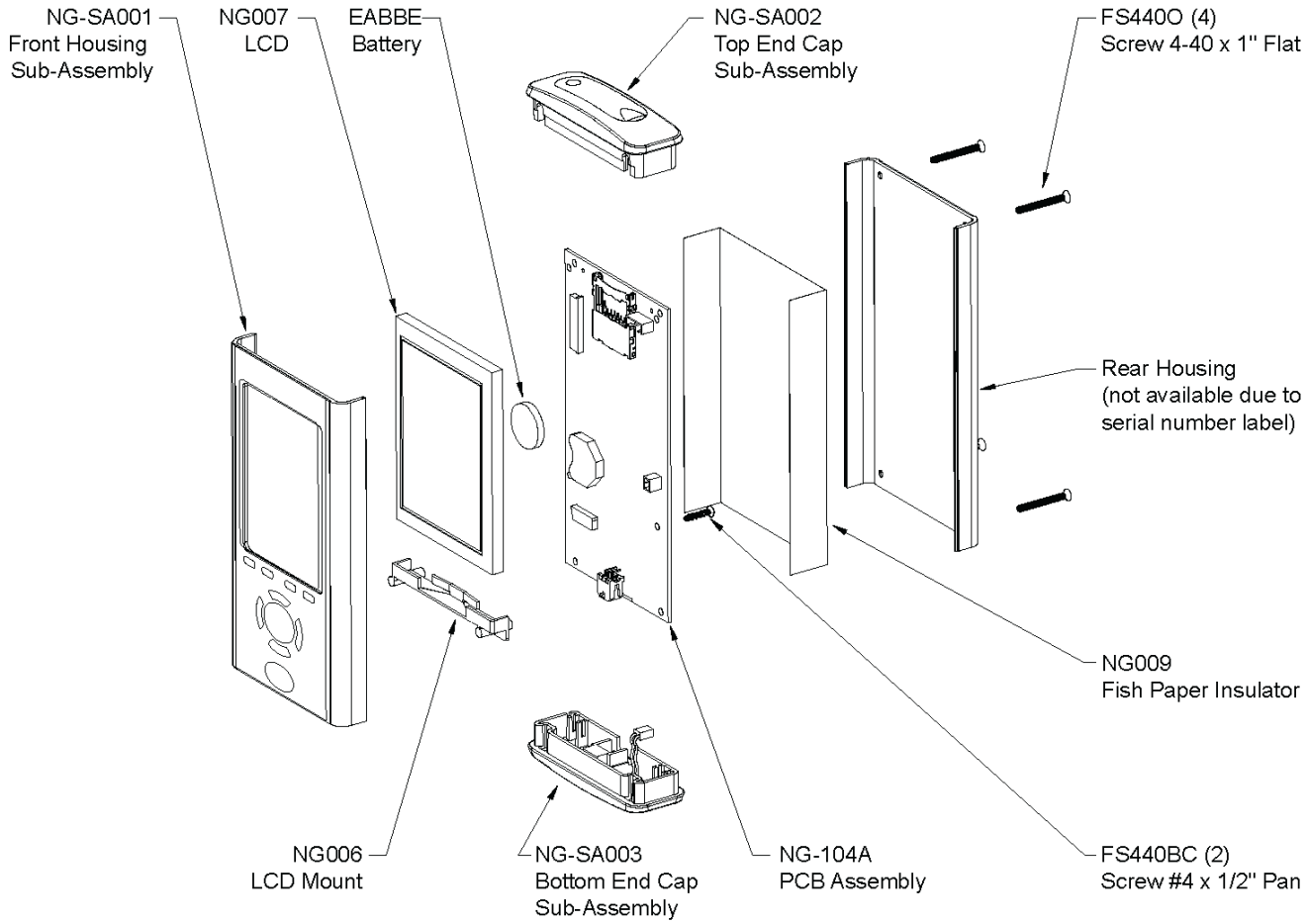


L480SA005P; SUB–ASSEMBLY, 480E PRO MOTOR

14.10 Motion Controller Assembly (480/480E)

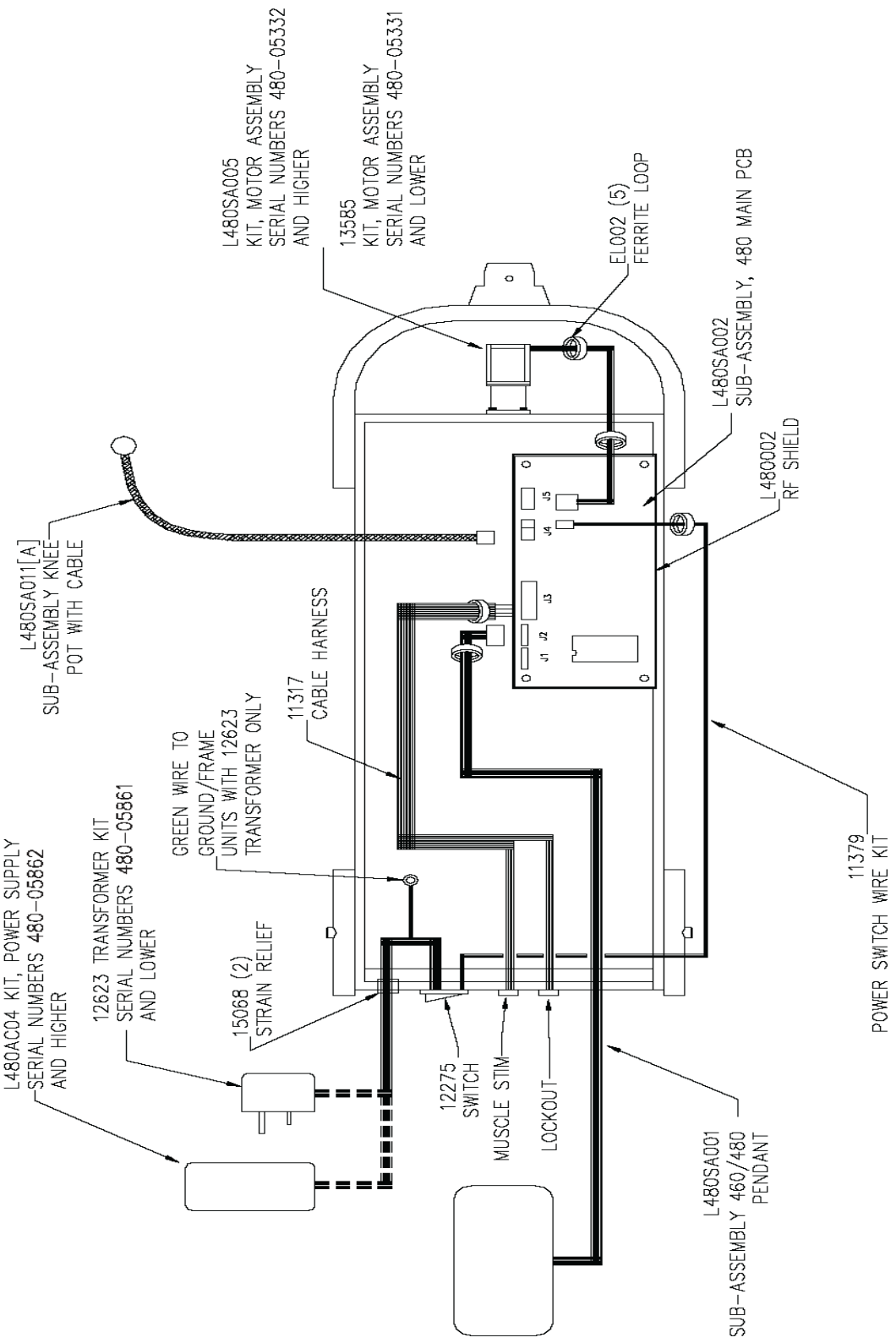


14.11 480E PRO Controller Assembly

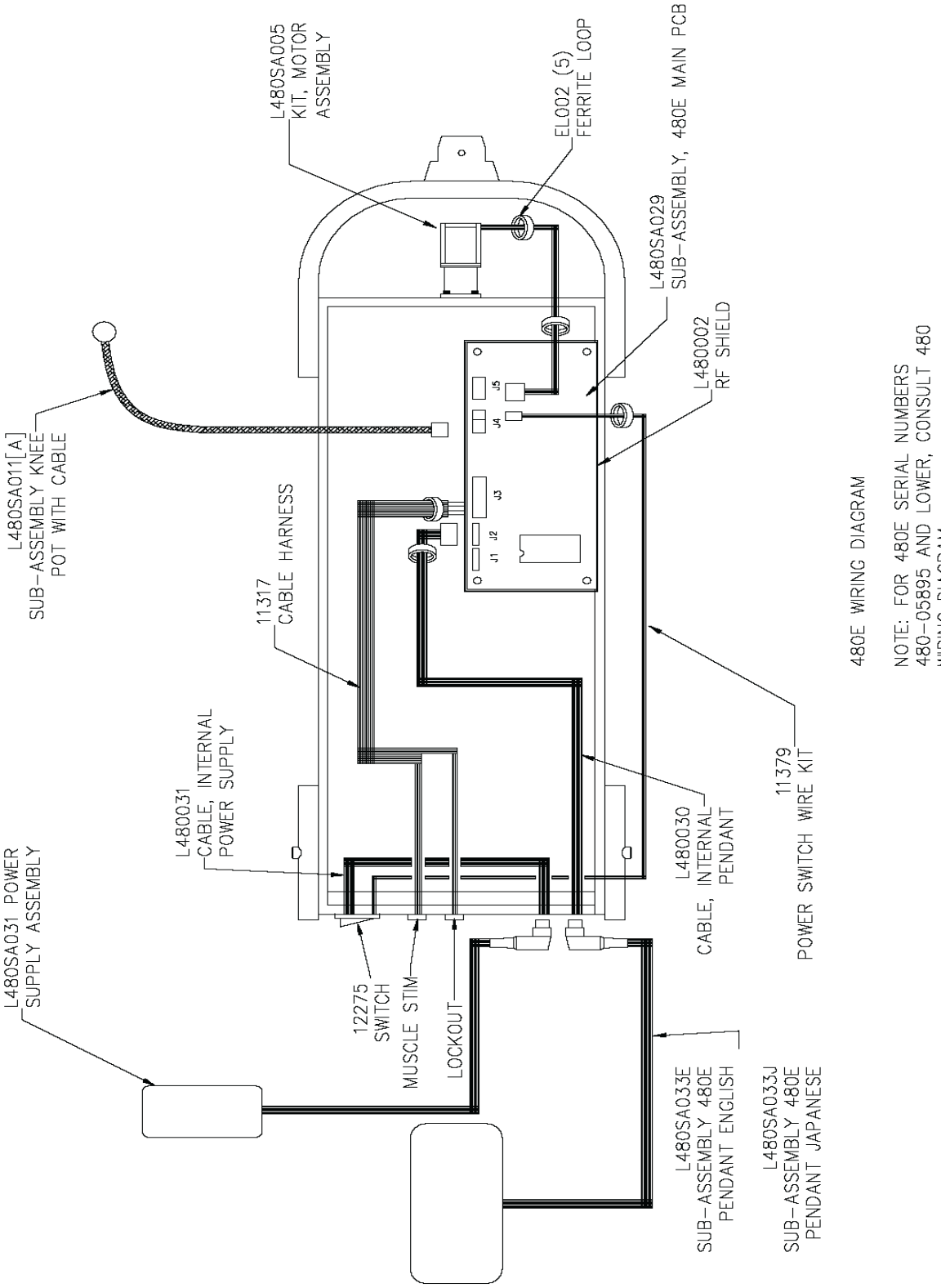


480E PRO: NG-104, Pendant

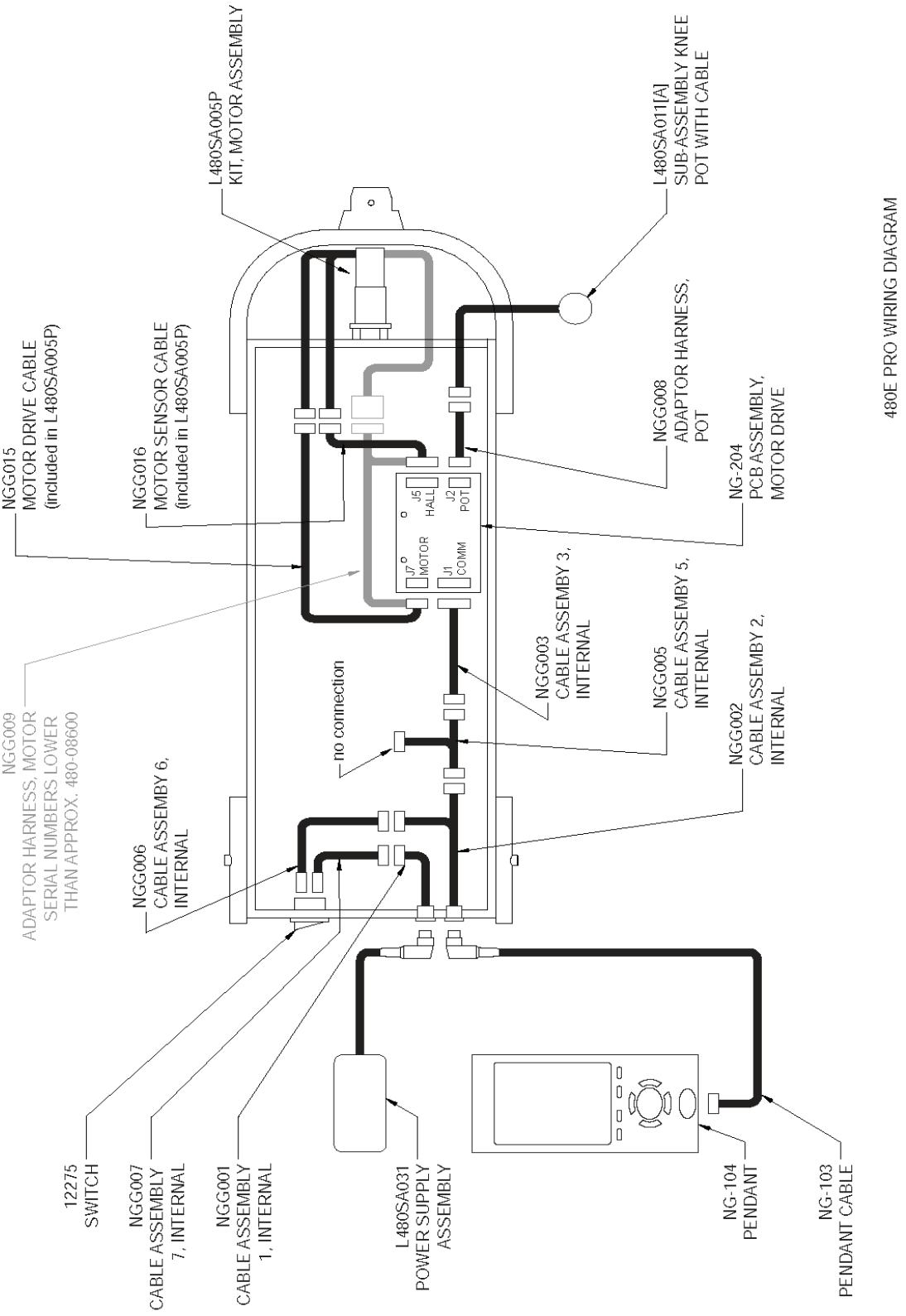
14.12 480 Wiring Diagram



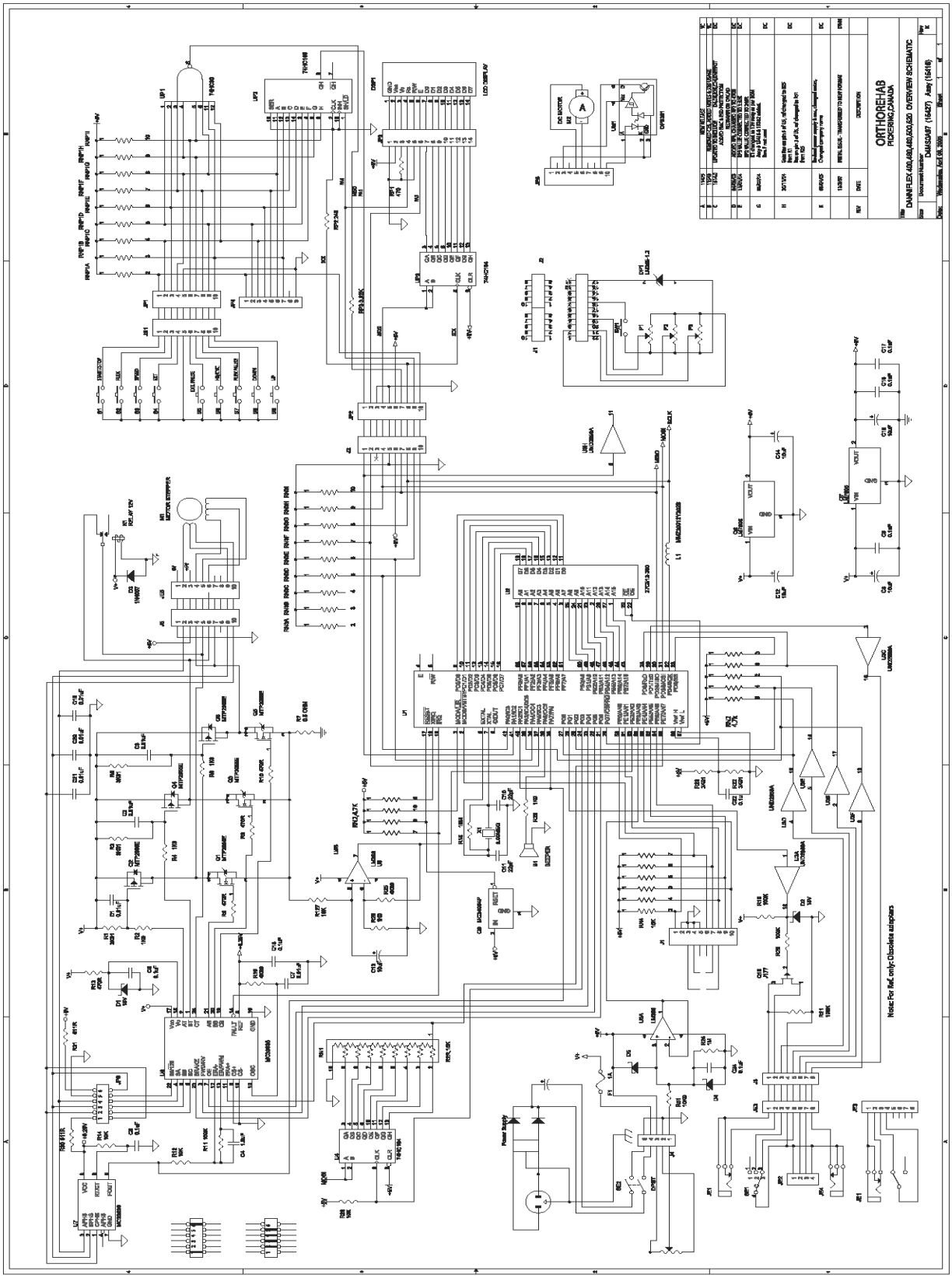
14.13 480E Wiring Diagram



14.14 480E PRO Wiring Diagram



14.15 480/480E Electrical Schematic



CUSTOMER CONTACT:
QAL Medical, LLC
(A division of Quality Assembly and Logistics, LLC)
3000 Woleske Road
Marinette, Wisconsin 54143 USA
1-888-430-1625; 1-715-735-4727
E-mail: info@QALMedical.com